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A New Employers' Association?

If Dame Rumour be correct there are movements on foot designed to establish an employers' association in the heavy non-ferrous foundry industry. The need for this is felt, not so much for negotiating with the trades unions as there exist several associations quite adequate for the purpose, but rather because of the not too remote possibility of a block allocation of fuel for the industry, coupled with that of the impact of concentration, should this step be taken. Experience has shown that it is wise completely to separate associations which deal with labour from those which cater for all the other various activities. The objects which should animate such a body as is being envisaged can be classified as follows:—

Co-operation with Allied Bodies.—Whenever the Service Departments or the great public-utility concerns such as railway companies issue an edict impacting on the foundry industry, a representative body of the brassfoundry owners should be in a position immediately to take their place at the side of other foundry organisations so that the departments may have the considered opinion of the whole of the industry. Next, the brassfoundry industry as a whole must be in a position to implement the technical requirements consequent upon war conditions, and this involves full co-operation with the Non-ferrous Committee of the Institute of British Foundrymen and the Non-ferrous Metals Research Association.

Service to Member-Firms.—It must be remembered that many brassfoundries are of but small dimensions and are owned by men who are essentially individualistic in outlook and who for the first time in their lives have felt the need for help in the conduct of their businesses. They require help with such questions as factory regulations; insurance in all its many and varied aspects; coupons for workers; edicts relating to scrap; income tax and costing. On the technical side there are daily arising new problems in connection with new specifications having for their object the conservation of essential raw materials, the latest of which is, of course, fuel. Because there are fewer really large concerns in the brassfoundry industry than in either iron or steel, there is obviously greater difficulty in reinforcing local committees with technicians capable of influencing beneficially the general level of good housekeeping. Thus a strain is being placed upon the technicians associated with this industry, and the best possible use must be made of those available for assisting in promoting its technological economy. Just as the question of man-power reservation showed clearly the necessity for urgent and unified action to be taken by the ironfoundry industry and the later action of concentration provided ample evidence of the wisdom of the steps, it may well be that bulk allocation of fuel will cement, in a similar manner, the brassfounders.

Economic Price Levels.—This feature is often the *raison d'être* of an employers' federation and it is accomplished by either the establishment of a price list or more modernly on a basis of a nationally unified costing scheme. The former is excellent, providing that it can be effected by agreement with an appropriate association representing the buyers, such as, for instance, the Builders' Merchants' Association. However, the second system is to be preferred where the output is as varied as that of the jobbing foundry.

Service to the Customer.—Outstanding in importance is the service which can be given to the customer. It is in this direction that an employers' association can do most to assure the prosperity of the industry it serves. It is to America that

(*Continued overleaf.*)

Contents

A New Employers' Association? 87.—Institute of Metals, 88.—Foundry Trades' Equipment and Supplies Association, 88.—Notes from the Branches, 88.—The Foundry Industry and Air Warfare—III, 89.—Precision Castings, 95.—Blast Control in the Foundry Cupola, 96.—Low-Tin and Tin-Free Bronzes and Brasses, 97.—Canada's Standard Stoves, 100.—Boosting Blast Furnace Output, 101.—South African Strategic Minerals, 102.—Book Reviews, 102.—New Patents, 104.—News in Brief, 104.—Workers' Clothing Coupons, 106.—Personal, 106.—Company News, 108.—New Companies, 108.—Obituary, 108.—Raw Material Markets, 110.

INSTITUTE OF METALS

The Thirty-Fourth Annual Autumn Meeting of the Institute of Metals was held at the offices of the Institute, 4, Grosvenor Gardens, London, S.W.1, on Wednesday, September 23, 1942. Lieut.-Colonel Sir John Greenly, K.C.M.G., C.B.E., M.A. (President), occupied the chair. After the minutes of the last meeting and the election of 41 members and student members had been confirmed, the secretary (Mr. G. Shaw Scott) read the following list of nominations made by the Council as officers for 1943-44:—

President: Lieut.-Colonel Sir John Greenly.

Vice-Presidents: Dr. Maurice Cook (Birmingham), Colonel P. G. J. Gueterbock (Bristol), and Mr. A. J. Murphy, M.Sc. (London).

Members of Council: Sir Clive Baillieu, K.B.E., C.M.G. (London), J. Cartland, M.C., M.Sc. (London), Dr. A. G. C. Gwyer (Warrington), and Dr. C. Sykes (Teddington).

It was stated that the result of the election of the new officers would be announced at the annual general meeting, to be held in London in March, 1943.

After the conclusion of formal business, the following Papers were presented for discussion:—"The Cold-Pressing Properties of Duralumin-Type Alloy Sheets, with Special Reference to the Production of Large Pressings for Aircraft," by Messrs. J. C. Arrowsmith, K. J. B. Wolfe and G. Murray; and "Railway Bearing Metals: Their Control and Recovery," by Messrs. J. N. Bradley and Hugh O'Neill.

FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION

The Annual Meeting was held last Wednesday at the National Liberal Club, Mr. G. E. France presiding. It was preceded by an informal luncheon, and amongst the guests were Capt. King and Capt. Maddox, both of the U.S. Army, and Mr. A. Graham, of the Light Alloys Control. The last named in a short speech announced that Mr. France had been appointed a technical adviser for aircraft production.

No changes were made in list of officers, except that Mr. K. W. Bridges, who has been temporarily released from the Army, resumes his position as honorary secretary. The Association continues to act as the organisation charged with the allocation of dextrine under the Ministry of Food. During the year 1941, no changes in membership were recorded, whilst the balance-sheet showed a profit of £14 for the year.

New Zealand Bentonite—A deposit of bentonite is being exploited in the Hawkes Bay district of New Zealand, reports "Ceramic Age." Production in 1940 totalled 205 long tons, all consumed locally—chiefly in the regeneration of moulding sand. The bentonite is being supplied in the crude form, but consideration is being given to drying and grinding, and processing generally. Although the deposit, which is located on the coast line, is difficult of access and transport, production is expected to assume importance in the future.

NOTES FROM THE BRANCHES

LONDON—EAST ANGLIAN SECTION

The final meeting of the 1942 session was held in the Central Library, Ipswich, on September 19, Mr. C. J. Lake presiding. The meeting was addressed by Mr. E. M. Currie on the subject of the "Gating of Castings," which he illustrated with coloured films and lantern slides. The lecture received the same wholehearted approbation as when it was first delivered in London. During the discussion, Mr. Currie, replying to a question asked by Mr. L. E. Slater, said it was a good plan to try out any new core oil or compound in a similar way by making up some cores, baking them and then casting metal round them in an open sand mould. Any gas evolved or disturbance of metal was then readily observed.

MR. D. CARRICK raised some points about the relative position of the strainer core and sprue. MR. CURRIE said that with the sprue directly above the strainer core there was more likelihood of breaking the core if the distance between the two was considerable. He added that large cores up to 8 in. square and 1 in. thick had been used, but consideration must be given to their adequate support. Also it must be borne in mind that oil sand will not stand up for long to the continued passage of liquid metal.

MR. C. J. LAKE thanked the author for his address which was both interesting and of great importance in that many of the points he raised were so often neglected and contributed thereby to the production of waster castings. Also it formed a fitting conclusion to a session which had been devoted to the discussion of how to overcome casting difficulties.

Mr. Currie made a brief acknowledgment in which he thanked Mr. C. J. Lake for providing the Cine projector and operating it.

A NEW EMPLOYERS' ASSOCIATION?

(*Concluded from previous page.*)

one must turn to study the best examples of this enterprise, and ranking high amongst trans-atlantic organisations is the Steel Founders' Association. By its publications it has materially helped engineers to improve their practice and productions. The above is a fairly long, but by no means complete, listing of the duties to be expected from the modern employers' association, but so far as it applies to the British brassfoundry industry, the one outstanding necessity is for the owners very rapidly to organise their affairs so that they can speak and act with authority, for the whole of the industry without question.

American warplane production in the first six months of 1942 exceeded the entire 1941 output, according to the president of the Aeronautical Chamber of Commerce of America.

THE FOUNDRY INDUSTRY AND AIR WARFARE — III

A LIGHT-ALLOY FOUNDRY OF ROLLS-ROYCE LTD.

Control and Inspection practice at a light-alloy foundry making Merlin XX Aircraft Engines

(*Continued from page* 54.)

The Light Alloy Foundry

New fields were certainly open to conquer to the Rolls-Royce foundry engineers when the decision was made at the request of the Ministry of Aircraft Production to install a mechanised light alloy foundry for the mass production of Merlin XX engine castings. Whilst mechanisation was fairly commonplace in iron-foundries throughout the country, little or no mass production technique had been introduced into light alloy foundries, and more especially those foundries engaged on the production of really complex aero engine castings. Flexibility of operation and control has obviously been the keynote on which the layout and equipment was planned, provision having been made wherever possible to safeguard continuance of production by a sensible sub-division of the most vital items of equipment.

The layout is planned to give a continuous flow of raw materials from the railway siding at one side of the building into finished castings delivered into the machine shops on the opposite side, and when one realises that in the average foundry not mechanised 275 tons of material are handled to produce 1 ton of castings, whilst in the plant under review this ratio has been reduced to as low as 120:1, it will be appreciated what has been achieved. Moulding and core sands, delivered by rail truck, are discharged through a grid at floor level outside the foundry, and transported by rotary table feeder and elevator into storage hoppers. Two of these hoppers, each holding 30 tons of core sand, are shown in Fig. 23. This sand, being invariably delivered in a wet condition, is then passed through a large rotary drier with an output of 4 to 5 tons per hr. and discharged into an airlift system which deposits the then dried and cooled sand into a cyclone and then into large storage hoppers immediately over the core-sand mixers on the roof above the actual coreshop.

Core Sand Preparation

Predetermined quantities of this sand are then discharged by batch measures into the core-sand mixers, and the requisite amounts of binding constituents of linseed oil, dextrine and molasses are added, and mixed thoroughly into the sand, according to instructions laid down by the foundry control laboratory, before discharging from the mixers into the bottom opening tubs shown in Fig. 24.

Operated entirely by girls, these bottom opening tubs discharge the mixed core sand directly on to the coremakers' benches, clearly indicated in Fig. 25, the female operators indicating by warning light connected from the hoppers to the distribution platform above, when further supplies of core sand are required. Some idea of the extent to which female labour is employed in this foundry can be gathered from this view of the centre bay of the coreshop in Fig. 25. These girls can be justifiably proud of their reputation for producing really first-class cores at remarkably high rates of production.

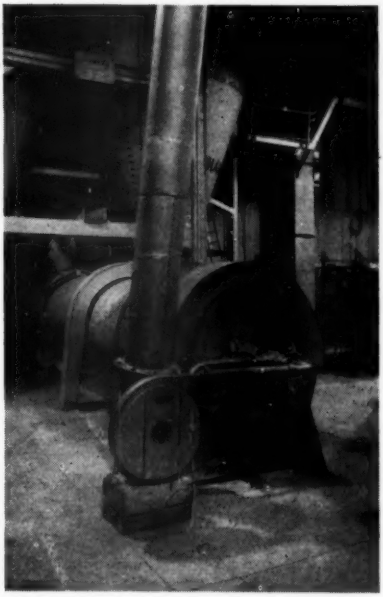

FIG. 23.—CORE SAND DRIER AND STORAGE HOPPERS.

Coremaking

Pages could be written of the various manufacturing problems met with by the management in this department, and the ingenious devices developed to overcome these difficulties to render the production of intricate cores by female labour possible, but no doubt exists in the writer's mind that this must surely be one of the finest planned and most efficient coreshops to be seen in the country. To quote but a few examples of

A Rolls-Royce Light-Alloy Foundry

the astounding achievements, a reference to Fig. 26 shows a girl coremaker engaged on the manufacture of the intricate jacket core for the Merlin XX cylinder block, recognised to be one of the most difficult cores on the engine to produce. Admittedly, she is assisted by a coremaking machine, which eliminates entirely all the fatigue of rolling over and stripping a heavy corebox from the finished core to which is fitted a really first-class all-metal corebox. This girl, who is one of several girls trained on this particular core, normally produces 30 first-class cores per shift, with a skill which has astounded even the most highly skilled coremaking craftsman in the industry locally. A further example of how mechanised assistance brings the larger cores well within the scope of a female coremaker, is shown in the manufacture, again on a rollover core machine, of a large block core for the Merlin XX wheelcase casting.

A further group of intricate cores manufactured by girl coremakers with the assistance of cast-iron core carriers, which are an exact replica of the corebox already mentioned in the description of the patternshop, is given in Fig. 27. Without this specialised method of assistance, the work in connection with these cores would be well outside the capability of the girl coremakers, which all goes to prove that, provided the necessary facilities are given, the possibilities of girl labour in core production are unlimited.

Steel band conveyors are used for transporting the cores from the coremakers' benches to the core stoves, the lower strand of the conveyor being used for the return of the coreplates to the coremakers' benches.

Coremakers—coremaking is the policy of Rolls-Royce in this section, and all the auxiliary operations such as preparing and bending to shape the wires

FIG. 24.—CORE SAND MIXER AND DISTRIBUTION BOGEYS ON GALLERY.

FIG. 25.—VIEW OF CORESHOP.

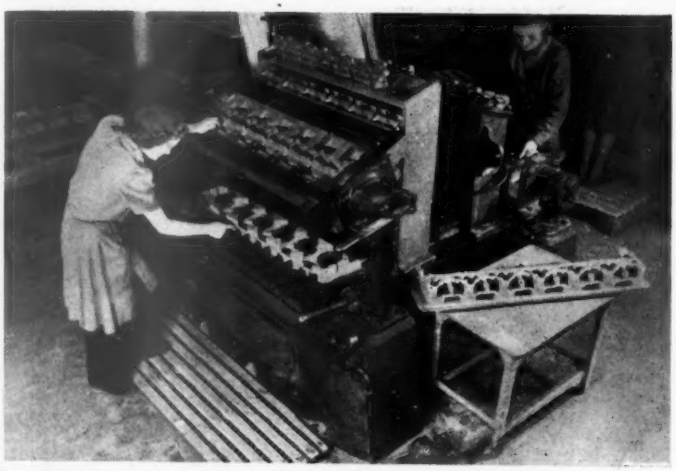

FIG. 26.—MAKING MERLIN XX CYLINDER BLOCK JACKET CORES ON COREMAKING MACHINES.

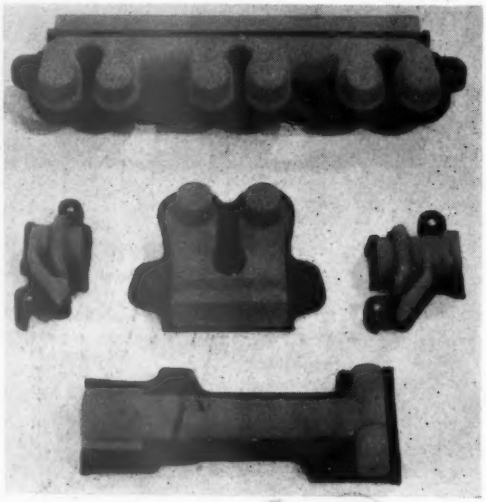

FIG. 27.—GROUP OF SMALLER INTRICATE CORES MADE BY FEMALE COREMAKERS WITH THE ASSISTANCE OF CAST-IRON CORE CARRIERS.

used to reinforce the core, sorting and preparing chills for insertion in cores, are dealt with in sections occupied whole time on this work. The result is that the female coremakers keep the valuable pattern equipment in full-time operation and readily become expert, whilst for example in the core wire-bending section, other girls have developed a knack of turning out thousands of wires bent accurately to shape in jigs prepared for the purpose. Truly a policy which cannot fail to yield maximum production, which at the present time numbers many thousands of cores per week.

An interesting side view of the coremaking department is shown in Fig. 29. One of the two 170-ft. long steel-band conveyors can

FIG. 28.—GAS-TESTING A VOLUTE CORE FOR A DIE-CAST COOLANT PUMP (NOTE LEAK INDICATED BY ARROW).

A Rolls-Royce Light-Alloy Foundry

be clearly seen between the lines of core-makers' benches, whilst the combination of coresand mixing, distribution, and hopper supply is illustrated particularly well. The baking of the cores is carried out in continuous, automatically-loaded, vertical core stoves of varying sizes to suit different types of cores, the baked cores being discharged on to one of two pendulum-type conveyors, which carries them through the remaining operations into the moulding bay ready for setting in the moulds.

Coredressing

Each individual core as it arrives at its appropriate station on the pendulum conveyor is carefully trimmed to remove all flashes of sand, checked with inspection gauges and painted where necessary, before passing to group inspection, where its accuracy in relation to the remaining cores which go to complete a set is checked.

Certain of the cores in an assembly may be gas-tested to ensure that the venting system is satisfactory. This gas-testing operation is illustrated in Fig. 28, where a volute core for coolant pump is shown with a bad leak through which the gas circulated inside the venting system is leaking and has ignited. Obviously, this leak, unless detected and sealed, is a potential source of danger due to either metal entering the core and choking the vent, thus preventing the egress of gas from the core, or to trapped core gas being expelled on expanding after the pouring operation into the aluminium in the molten condition, and creating an aluminium oxide inclusion in the casting.

Group inspection on the wheelcase casting is clearly illustrated in Fig. 18. Here it will be seen that each individual core is assembled on a master location plate having dowel locations corresponding to those in the ultimate mould. In this instance, steel bushes are rammed up and dried in position in the various cores for locating on the dowels mentioned. These location bushes can be clearly seen in one of the cores in Fig. 18. Obviously, by this method, the human element is eliminated in the operation of core setting, and it is, therefore, possible to group-inspect a set of wheelcase cores and guarantee that all sectional thicknesses will be correct on the later setting in the mould and in the ultimate casting.

After passing group inspection, the completed set of cores is reloaded on to the same pendulum conveyor and transported

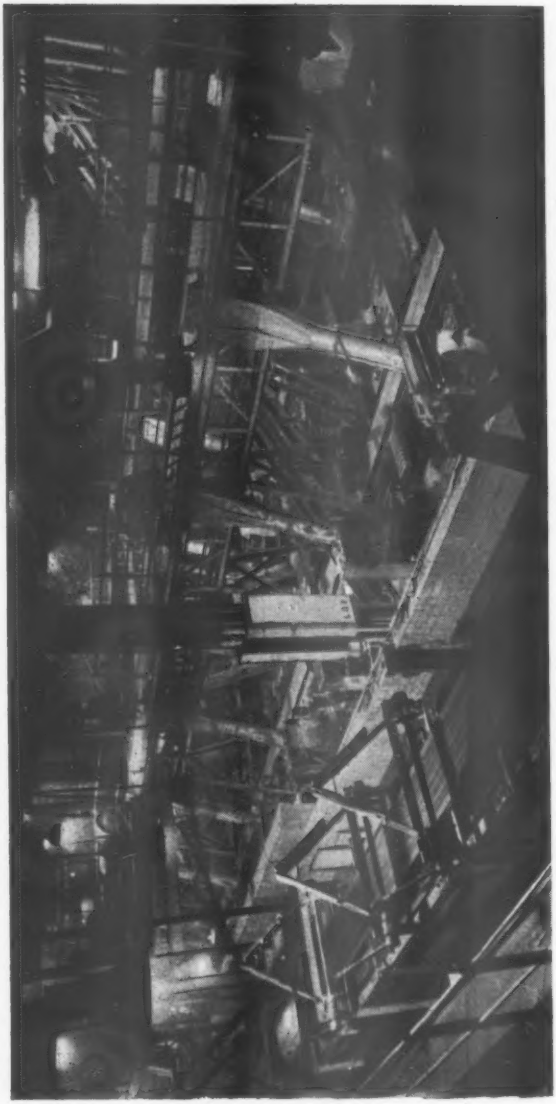

FIG. 29.—VIEW OF CORESHOP FROM GALLERY.

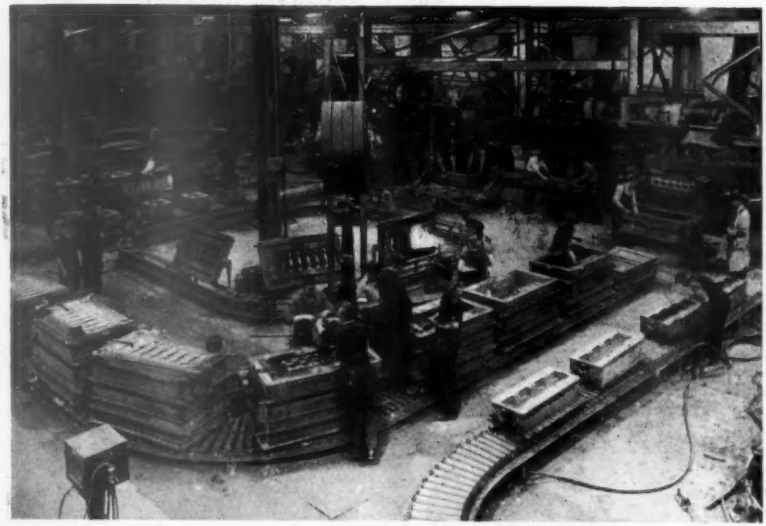

FIG. 30.—MERLIN XX UPPER HALF CRANKCASE MOULDING BAY.

FIG. 31.—GENERAL VIEW OF ONE OF THE MAIN MOULDING BAYS IN THE FOUNDRY.

by this means through a drying tunnel to ensure that the last vestige of moisture is dried out of the cores before they pass into the core stores ready for issue to the moulding bay.

The general view of a portion of one of the core-dressing sections in Fig. 32 shows the pendulum conveyor passing through the drying tunnel at the far end and returning into the core stores immediately behind the moulding bay. Here again in the core-dressing section female labour has been introduced to a very large extent. Some idea of the magnitude of the core production problem can be gathered from the fact that there are over 300 individual cores used on the production of every Merlin XX engine.

Moulding Sand Preparation

The generally accepted practice, and one which still prevails in many light alloy foundries, that the moulding sand used for the production of satisfactory aluminium castings must comprise two distinct qualities, namely, "facing sand" for forming a first layer of sand over the pattern, and "backing" sand which, as the name implies, is used to back up the facing sand and fill in the remainder of the moulding box, has been well and truly exploded in the foundry under review. Here, the whole of the moulding sand in circulation in the mechanical handling system at a rate of 15 tons per hr., is of uniform composition,

A Rolls-Royce Light-Alloy Foundry

and serves as a combined "facing" and "backing" sand.

Furthermore, there is nothing of a synthetic nature used in building up the moulding sand employed. It is produced and balanced by careful blending of naturally-bonded sands under laboratory control to give the required green strength, dry strength, permeability and flowability for the satisfactory production of moulds and castings by mass-production methods. This important factor of maintaining a uniform sand throughout the whole of the moulding system achieved by the laboratory, in collaboration with the supervision in the moulding bay in the early days of planning the foundry, has eliminated conditions which must have inevitably proved to be a serious production bottle-neck in the drive for quantity production which has since followed

The plant installed for mixing, distribution and reconditioning the moulding sand is outstanding, and deals with the problem in a manner which enables and assists the laboratory to maintain this rigidly scientific control at all stages in the processing. The various naturally-bonded sands are delivered, as mentioned earlier, by rail truck and discharged through a grid at floor level into the moulding sand storage hoppers inside the foundry building. Batch mixing is carried out in a battery of four August-Simpson mixers, each of which has an output of 5 tons per hour.

Batch mixing of moulding sand is regarded in this foundry as an all-important and essential condition as opposed to continuous mixing in the maintenance of scientific sand control. With batch mixing, accurately controlled percentages of new sand and moisture can be added to each batch of known volume, whilst carefully predetermined mixing and mulling periods can be maintained to ensure absolute uniformity of sand conditions throughout the foundry.

Fig. 33 is a general side view of the mixing section for moulding sand, showing an inclined conveyor in the foreground which is the first stage in the distribution to the foundry, whilst in the background of Figs. 30 and 31 can be seen the storage hoppers above each moulding machine, into which the mixed sand is finally discharged ready for use.

(To be continued.)

FIG. 32.—GENERAL VIEW OF COREDRESSING SECTION.

FIG. 33.—GENERAL VIEW OF SAND-MIXING SECTION SHOWING INCLINED CONVEYOR AND MAGNETIC SEPARATOR.

PRECISION CASTINGS*

Using a combination of the lost-wax process, a new highly-refractory lining and centrifugal casting.

By W. A. PHAIR

The production of non-ferrous and ferrous castings, including stainless and other alloys, to unusually close tolerances is being accomplished currently by a method combining the so-called lost-wax process, a new type of a highly refractory investment in place of sand, and centrifugal casting. This process, developed by the New Method Casting Company of New York, has aroused the interest of many design engineers in plants producing war equipment.

Castings are being produced by this company in aluminium, bronze, beryllium copper, cast iron, carbon steel, stainless steels and several other alloy analyses to tolerances of 0.001 in. on all surfaces. A few small pieces are being produced which are being held to tolerances of up to 0.0005 in. in all directions.

Aside from the higher degree of dimensional accuracy possible with this new process, complex sections and surface designs are being reproduced with

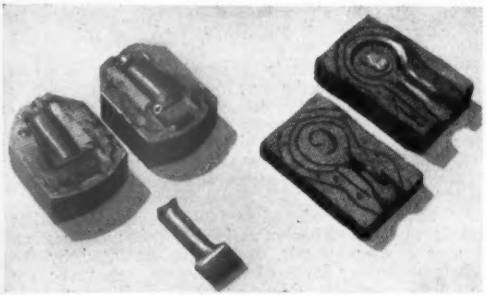

FIG. 1.—SAMPLE MASTER MOULDS IN BISMUTH ALLOY (LEFT) AND RUBBER. THESE MOULDS ARE USED TO PRODUCE THE WAX FORM. PRODUCTION MOULDS WOULD CARRY A NUMBER OF IMPRESSIONS.

excellent accuracy. Behind the never-ending search of foundrymen for greater dimensional accuracy, a search, particularly fruitful during the past two years, has always been the desire to reduce, if not completely eliminate, machining operations. This factor has been the motivating force in the adoption of this new method by various war industries.

When a casting is to be made by this process, the master pattern is usually developed directly from a stock sample of the part, whenever possible, to save pattern costs. This sample is reproduced in a bismuth alloy master pattern (Fig. 1), or in a rubber or plastic mould, depending upon the design and number of pieces to be made. It will be noted that the master pattern combines both the pattern and the mould. It is in two parts to permit removal of the sample. Where castings carry undercuts or have cored sections, the pattern is made with removable sections.

One Pattern per Mould

When the master mould is completed, it is used to form the wax core or pattern. Usual foundry terminology is somewhat confusing in describing this process, as each mould has its own pattern—a wax pattern which is destroyed in the process of making the casting. In effect, this pattern might be considered in the same light as a hard sand core, differing only in that it produces the entire cavity.

The master pattern shown in Fig. 1 is the simplest form of pattern used with this process. On production runs, the pattern will carry several castings, the exact number depending upon the size of the piece. On the average production casting, such as threaded brass pipe fittings, small stainless steel gear wheels, and the like, requiring no machining, there would also be removable sections representing the cored areas. Fig. 1 is a ring cast in one piece on an experimental basis during a study of the possibilities of this casting process.

After the wax has been poured into the master pattern, it is permitted to solidify and is then removed. This wax form is then placed on a flat metal base. A cylindrical flask is placed over this form and the liquid investment is poured into the flask. The flask is vibrated electrically to remove the air. On some castings vacuum is employed to assure thorough removal of the air. This treatment is followed by a cold setting period of about 8 to 10 min., during which time the investment becomes quite hard.

The mould is then placed in an oven for about 2½ hrs., and undergoes a slow baking at constantly rising temperatures. When the proper temperature has been reached, the wax becomes liquid and is removed by turning the mould upside down and letting the wax run out. The flask at this point is ready for pouring. This is done in a centrifugal casting machine while the flask is still extremely hot.

After the casting temperature has dropped past the critical zone, the flask is removed and the mould material knocked off the casting. This cooling requires 15 to 30 min. Some castings are quenched and some tempered, if necessary. Sand-blasting is employed for a final removal of any material which may remain in corners or cored sections.

It is obvious that the two key points of the process are the wax and the refractory. And as has always been the case where the lost-wax process is involved, there is considerable reticence in divulging the composition of the wax and the investment. The base material used for the wax form is, however, a comparatively plentiful domestic grade, treated to eliminate residue and to hold shrinkage to a minimum. For much closer dimensions, experimental work is being done to replace wax with low melting point metals.

(*Continued on page* 96.)

* Slightly abridged from "The Iron Age."

BLAST CONTROL IN THE FOUNDRY CUPOLA

AUTHORS' REFLY

On behalf of himself and Mr. Herres, the co-authors of the addendum, "Blast Control in the Foundry Cupola," to the Fifth Edward Williams Lecture (London, June, 1942), Mr. C. H. Lorig writes: "I was very glad to receive a copy of the communication* from Mr. Hallett regarding the use of chart, Fig. 1, for differential flow measurement corrections. Mr. Hallett is, of course, correct that for differential flow measurements the volume varies as the square root of the differential. It was neglect on our part to have ignored this factor in describing the application of Fig. 1, hence, we are very grateful to Mr. Hallett for calling this omission to our attention.

"It would appear to us the above omission could be rectified most simply by recasting the paragraph beginning with 'Provided the volume is determined by a differential type . . . .' as follows:—

"Provided the volume is determined by a differential type of volume meter, a simple correction can be made with the aid of a chart, such as shown in Fig. 1 to obtain a given weight of oxygen per unit time. Temperature and barometer readings are taken at a protected point near the blast intake, or for greater precision, at the point in the system where the blast is measured (the thermometer should be shielded from radiant heat either from the sun or a nearby furnace). Fig. 1 gives the absolute changes in volume resulting from changes in temperature and pressure. For a differential meter with linear calibration (inches of water) where the change in head is directly proportional to the volume change, Fig. 1 can be applied directly. On the other hand, Fig. 1 does not apply directly for a differential meter with a square root scale (cub. ft.). In that case, the change in volume is proportional to the square root of the values appearing on Scale V. To apply the corrections to a differential meter with a square root scale it will be necessary to multiply the indicated volumes by the square root of the per cent. of normal blast obtained from Scale V. A straight-edge placed in line with the temperature reading on Scale T_{db} of Fig. 1 and the barometer reading on Scale B gives the percentage of normal blast on Scale V. The cubic feet per minute of blast desired (for normal conditions) is multiplied by this percentage, or by the square root of this percentage of the volume is measured by a differential meter calibrated in cubic feet, and the blast control regulated to give the volume reading obtained as the product."

ALL STOCKS held by French industry containing more than 30 per cent. of copper, lead, tin or nickel have been confiscated by the French Government.

THE GOVERNMENT OF PERU and a North American firm have signed a contract for the construction of blast furnaces and iron and steel works at the Port of Chimbote.

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* "Foundry Trade Journal," August 27, 1942, p. 390.

PRECISION CASTINGS

(*Continued from page* 95.)

The refractory material is very fine (it will pass through a 340 mesh when dry). The composition of this investment is adjustable to suit the type of metal being poured and is quite capable of withstanding the high temperatures involved in pouring stainless steel castings. Despite its density, the investment is self venting in that its structure is sufficiently porous to permit gas to escape through the investment. While there are refractory mixtures available which will stand up to 2,160 deg. C., the bulk of the work is being done in the range of 1,535 to 1,750 deg. C. The flask material does not create gas when receiving the molten metal.

Gating of these castings is extremely simple and is established in the master mould. The diameter of the gates averages about one-twelfth the greatest thickness of the casting. A button is used to serve as a reservoir. Moulding is standardised in a 3 by 3-in. flask, the number of castings to a flask being determined by the size of the casting. The daily output from a mould ranges from 200 to 300 pieces, depending upon size. The chief limitation of the process is the size, with the capacity at the present being limited to a maximum size of 2¼ by 2¼ in. Experimental work is under way covering the casting of larger pieces.

The production line is arranged so that one group of workers produces the wax impression, while another pours the flask material. The economics of this process are somewhat complicated by the size limitations at present, but, within its workable range, it is finding use for many small parts, in many cases becoming part of an assembly without any further machining.

An outstanding advantage is the field of stainless that it opens. Other precision methods of casting, such as plaster moulds, are usually defeated by the high temperatures involved in stainless. However, the refractory used by this new method is apparently capable of handling stainless satisfactorily. Four patents covering the process have been applied for.

BOOSTING BLAST FURNACE OUTPUT

(*Concluded from page* 101.)

materials in the total burden the flue dust produced has dropped to less than half that present in a furnace operating a sinter-free Lake Superior ore burden.

Table I summarises the effect of sinter on blast-furnace operations. Reduced to specific terms it can be said that a blast furnace rated at 1,000 gross tons per day, consuming only its normal amount of coke, and with scrap being held practically constant can produce about 140 more tons per day with 45 per cent. sinter in the burden.

ANY MORE WASTE PAPER?

LOW-TIN AND TIN-FREE BRONZES AND BRASSES

Discussion of Reports at June Annual Meeting of the Institute of British Foundrymen in London

By MEMBERS OF THE NON-FERROUS SUB-COMMITTEE OF THE TECHNICAL COMMITTEE

At the recent annual meeting of the Institute of British Foundrymen, held in London, Section B, under the chairmanship of Mr. D. Howard Wood (Vice-President), discussed a Report on low-tin and tin-free bronzes and brasses, presented by the Non-Ferrous Sub-Committee of the Technical Committee of the Institute. The Report was based on an investigation made by the Sub-Committee into the possibilities of reducing the consumption of tin, in view of the need for economy. (See FOUNDRY TRADE JOURNAL, June 25 and July 2 and 9.)

The CHAIRMAN commented that the Non-Ferrous Sub-Committee had been particularly busy during the last four or five months in their investigations, which had arisen from the shortage of tin owing to the present emergency conditions.

DR. L. B. HUNT, presenting Parts I and III of the Report, dealing respectively with the casting of silicon bronzes and the founding of types A and B brasses, drew attention to the foreword to B.S.S. 1021/28, which outlined the policy to be followed in using the tin bronzes and silicon bronzes. It recommended that the 88/10/2 gunmetal should not be used unless essential, that the 87/9/3/1 alloy should not be used at all, and that wherever possible one of the two grades of cast brass made chiefly from scrap should be employed; it also drew attention to the uses that could be made of the silicon bronzes and aluminium bronze in all cases where manufacturers had experience of their use.

He added that the Non-Ferrous Sub-Committee had worked very closely with the British Standards Institution; five of the members of the Sub-Committee were members of the B.S.I. Committee, which had been responsible for drawing up the Specification.

General Policy Defined

With regard to Part I of the Report, dealing with the silicon bronzes as casting alloys, he said the members of the Sub-Committee had had a very long and wide discussion, without reaching very close agreement. It was felt that the average foundry, working on a mass-production basis, could not change over quickly to the use of the silicon bronzes, for which they might require special foundry practice and technique, and that in general the use of a lower-tin bronze would be much more simple. On the other hand, the Sub-Committee was pressed by the Non-Ferrous Metals Control to do whatever it could to make possible the greater use of alloys with low tin contents, or free from tin. The general opinion was that the members could not, as a Committee, make a general recommendation to use silicon bronzes in place of gunmetals, but that, where foundries could handle those alloys successfully, their use should be encouraged. Therefore, the best course was to publish some guiding lines on foundry practice which would help those who were considering the use of silicon bronzes.

Emphasising the importance of the problem of reducing tin contents, Dr. Hunt said figures had been given by critics who sought to show that the amount of tin used in bronzes nowadays was not very large. But he had it on unimpeachable authority that the amount of tin that was being used, until two months ago, in gunmetals, phosphor bronze, and so on, was advancing very rapidly, and that it had to be reduced drastically.

Finally, he expressed thanks to the Committee members, who had worked very hard on the subject since February, and to others who had joined in the work, particularly Mr. M. C. Oldham and Dr. W. O. Alexander.

Low-Tin Content Gunmetals

MR. FRANK HUDSON, presenting Part II of the Report, dealing with the properties of sand-cast low-tin content gunmetals and brasses, said it had been compiled principally to assist Service Departments, engineers and founders to apply the new Specifications to the products they designed or manufactured. In the beginning of Part II he had included, for convenience, 85/5/5/5 gunmetal and had compared it and the two new ones with the well-known Admiralty gunmetal 88/10/2, in order to give a quick and ready comparison so far as design and other matters were concerned.

The most important feature of Part II was the table of applications (Table V). He had drawn it up tentatively, and he asked for as much discussion as possible on those suggested applications; any suggestions as to additional applications would be extremely useful to those who might require guidance in applying the new materials. In conclusion, he said the original suggestion that he should draw up such a report had come from Mr. C. Coldron-Smith (of the Engineer-in-Chief's Department at the Admiralty), to whom thanks were due, not only for the idea, but also for having interrupted his hard-earned leave in order to be present at the meeting.

DISCUSSION

The CHAIRMAN, in a tribute to the Sub-Committee, said it was obvious that a vast amount of work had been involved in the preparation of the report; the

fact, he said, that the members of the Sub-Committee had been able to prepare it, in spite of the fact that their routine work occupied almost the whole of their time, was a great tribute to their keenness. Not only the Institute of British Foundrymen, but the country as a whole, owed a great debt to Dr. Hunt and the other members of his Sub-Committee for their work. The fact that the recommendations they had made had been embodied, in the main, in the new B.S.S. was in itself an acknowledgment of the value of the report.

(At this stage Mr. Wood had to leave the meeting, and at his invitation Mr. V. C. Faulkner (Past-President) presided during the remainder of the session.)

The Viewpoint of the Control

MR. H. J. MILLER (Non-Ferrous Metals Control) was grateful for the opportunity to make a few comments which might prevent the discussion taking a wrong turn. It was always very difficult, he said, for founders and other users of copper-base materials to know what the Control was thinking at any given time; indeed, it was rather difficult for the Control itself to know what course it should follow, for things were changing so very quickly. However, the Tin Section of the Control was definitely perturbed by the quantity of tin that was being consumed in the production of gunmetals and phosphor bronzes. It was now just about the largest single use of tin—bearing in mind that there had been a considerable cut in tinplate. Therefore, the situation was rather serious; of the quantity of tin consumed, about 30 per cent. was going into the tin bronzes and gunmetals. Whereas cuts had been made in other directions, as, for instance, in bearings, there had been no tendency to decrease the amount of tin required for the gunmetals. He had been reproached that it was the duty of the Control to take up with anyone who specified bronzes and gunmetals the question as to whether lower grade material could be employed, or whether an alternative alloy could be substituted, or whether the designers of the castings could reduce sections, and so on. That was a task which was rather beyond the capabilities of the limited staff available at the Non-Ferrous Metals Control, however, and he asked founders who received orders from various bodies and specifying engineers to appeal to them to consider alternative materials, such as the silicon bronzes, etc., which might possibly give even improved service; or, alternatively, to give to the Control their views on any of the individual applications.

The issue of the new specifications by the British Standards Institution was an excellent move: it had introduced two or three specifications for gunmetals containing reduced quantities of tin as compared with the normal, and also the specifications for the cast brasses. They would be followed by British Standard Specifications for silicon bronzes, aluminium bronzes and, maybe, other materials as well. The mere issue of specifications, however, was only the beginning of the task; the greater part of it was to ensure that the specifications were applied correctly in industry. Having made those remarks on the general position, no doubt the Control could count on the active co-operation of all the founders.

Raw Material Questions

With regard to the raw materials which should be used in compounding alloys to those various specifications, he said the 88/10/2 alloy, which in the past had been used always for the better-class products, would be partly replaced by the 88/8/4 alloy. In connection with the making of castings in the latter alloy, the Control would like the foundry industry to refrain from ordering ingots from secondary ingot manufacturers, especially if the founders could make the castings directly by one melt, using virgin metals plus their own process scrap. He made that request because the ingot manufacturing industry was rather overtaxed, and it was definitely wrong, and false economy, that that industry should be inundated with orders for the higher-grade materials, when it could not make them from scrap and had to use virgin metal largely. For the lower-grade leaded gunmetals—the 86/7/5/2 and the 85/5/5/5—the Control asked the founders to use scrap charges, or, alternatively, ingot metals purchased from the secondary ingot manufacturers, who were very clever in the use of mixed scrap to produce the desired compositions.

In the production of the cast brasses, of course, the Control wanted low-grade scrap to be used, either directly or, probably more conveniently in most cases, in the form of secondary ingots.

Commending the report to very careful consideration, Mr. Miller said the Control hoped that there would be a much greater use of such materials as silicon bronzes (which were better in service in many instances than the gunmetals) and of the low-grade brasses, for he felt that those were two directions in which most advance could be made.

Commenting on the statement in Part II of the report, that cast brasses, types A and B, were not recommended for use at elevated temperatures and that there were no published data available of their mechanical properties, he said he did not agree entirely. He believed the statement was taken from the British Standard Specification, with which he had had some connection; but he had overlooked it there, and it had been brought to his attention again by the Report. Certainly he would agree that cast brass, type B, which was an alpha-beta brass, would be poor at elevated temperatures, but he was not certain that that would be so in the case of type A, which would have a wholly alpha structure. It was quite true, as Mr. Hudson had stated, that there were no data concerning creep or other properties at elevated temperatures; but, having looked up the very few figures which had been published on wrought alpha brasses, he said they rather supported his view that, at temperatures up to 200 and 250 deg. C. (of the order of 400 to 500 deg. F.), cast brass, type A, might not be inferior to gunmetal.

Low-Tin and Tin-Free Bronzes and Brasses

Current Trends

MR. G. L. BAILEY (British Non-Ferrous Metals Research Association) said that the main difficulty, or one of the main difficulties, in ensuring the use of the alloys of the lowest tin content possible was that for certain applications the high-grade materials, such as the 88/10/2 alloy, were still required. It would be easier if it were possible to prohibit their use; but, unfortunately, that could not be done, and the high-grade materials had had to stand, with one exception, *i.e.*, the 87/9/3/1 alloy, which was often known as the grade 2 gunmetal of the pre-war specifications. The B.S.I. Committee had felt that there was nothing for which that alloy was used for which a substitute could not be used; therefore, the specification suggested that the 87/9/3/1 alloy should not be used. Of course, that was only a suggestion, for the specifications were only recommendations. It was hoped to replace the 88/10/2 by the 88/8/4 alloy in quite a number of applications, but not all of them. The most important point, in the view of the Committee, from the point of view of saving tin, was the introduction of the entirely new specifications for cast brasses. There was no doubt that many foundrymen very much liked to use the 85/5/5/5 alloy in particular for purposes for which tin-free secondary metal brass was quite good enough. He admitted that the brasses might give the founders a little trouble, particularly if they were accustomed to the use of the 85/5/5/5 alloy; when using the type B brass there was a danger, as had been pointed out by Mr. Hudson, when one came to the lower copper content of that range (62 to 70 per cent.), in that the technique had to be altered; it became very much a manganese bronze technique rather than a gunmetal technique. That was very much in the minds of the Committee. The original suggestion was for a type B brass of 60 to 70 per cent. copper; then there was a reference to an alloy containing 65 per cent. copper, but that was altered by the Committee to a minimum of 62 per cent. However, Mr. Bailey emphasised as strongly as he could that the cast brasses as a whole were the materials which certainly should be used wherever they could be used.

Foundry Propaganda Needed

With regard to Mr. Miller's indication of the attitude of the Non-Ferrous Metals Control on the matter, and of the fact that the Control had not the manpower to be able to consider each individual case on its merits, Mr. Bailey commented that the industry could help to a very great extent by advising customers as to the alloys they should use for their various purposes. It was necessary, however, first to make quite sure that the foundry industry was sufficiently familiar with the characteristics of the alloys; and it was from that point of view that the Report of the Non-Ferrous Metals Sub-Committee of the Institute had been prepared. He suggested that the foundry industry would be very well advised to experiment with such of the materials as were new to them, so that they would be in a position to deal with them if they were asked to do so. If they got to know and to like one of those alternative materials—he would not call them "substitutes," because some of them were equal to those which they replaced—they should be able to recommend its use to their customers with every confidence.

The Charcoal Enigma

From that point of view he was a little disappointed by the silicon bronze part of the Report (Part I). Dr. Hunt had called attention to the fact that, whereas one maker would say that charcoal must not be used, another would say that charcoal must be used; it might also have been mentioned that, whereas one maker held that there must not be any lead contamination, another implied that it was satisfactory. Mr. Bailey felt that the information given in the Report with regard to the silicon bronzes might with advantage have been extended a little, for it was in some respects contradictory, and it would not be easy for anyone who was a perfect stranger to the material to decide exactly what he was required to do.

Part II of the Report, dealing with the sand-cast low-tin content gunmetals and brasses, contained some extremely useful and interesting data, the collection of which must have been quite difficult, and the industry must be extremely grateful to Mr. Hudson for the trouble taken to collect it. Inevitably, however, there must be small points in respect of which there was not complete agreement. Referring to the behaviour of the brasses in corrosive conditions, he said there was no doubt that, in respect of resistance to the action of sea water, one of the main differences between type A and type B brass was that the β phase present in the type B was very liable to dezincification; and he did not think that at the moment anyone knew how to prevent it. In the type A material, which was an α alloy—he wondered whether it was possible to get a little β in a type A brass—arsenic and possibly antimony and phosphorus would prevent dezincification. He did not much like Mr. Hudson's suggestion that, in order to avoid dezincification in type A brass, there must not be more than 20 per cent. of zinc present. The point was that it must be an α structure.

MR. A. J. MURPHY (J. Stone & Company, Limited, and Chairman of the B.S.I. Committee on Cast Copper Alloys) said that there was indeed a great treasure of information in the Report, and by the publication of it the Institute was placing it where it could produce the results which were so much desired. It did not leave any important aspect of the matter undiscussed, so far as he could see.

Care Needed to Cast Type B

Leading up to the general point that the Report would give to founders a better appreciation of the qualities of some of the materials dealt with, he said that they must guard against the danger of supposing that some of the things which metallurgists had known in the past as geese had suddenly become rather remarkable swans. Type B brass was not a new invention; the foundry industry had fought shy of

Low-Tin and Tin-Free Bronzes and Brasses

making high grade castings with it, not because of prejudice, but as the result of some painful experiences. It was interesting that Mr. Arnott in his experiment of making a medium-sized casting (2¼ cwts.) in type B brass, using moulding and gating methods commonly adopted for gunmetal, had not brought the test to a successful conclusion. Mr. Arnott had observed that, in a casting of that size, the differences in characteristics between gunmetal and type B brass were considerable. The tests illustrated that, if a foundry were producing that particular casting in gunmetal and were required to change to type B brass, production would stop at once—assuming that the casting had to be of reasonably high quality—until the necessary changes of method had been ascertained. In the desire to save tin foundrymen must avoid waste of man-hours due to founders, who were perhaps not very experienced in the use of type B brass, falling into that sort of trouble. In saying that, he did not wish to criticise the work that had been done, but to stress a point which the contributors to the Report had already made.

Expressing appreciation of the remarks of Mr. Miller, and being aware that the Non-Ferrous Metals Control, with the aid of a very small staff, had to perform a giant's task, he asked them to believe that the industry was prepared to go more than half way to meet them. They could take encouragement, for example, from the fact, in connection with tin economy in plain bearings, that the industry had needed little more than a hint from the Control as to the direction in which its collaboration would be welcomed, and it had worked out what had proved to be an extremely successful means of saving tin. He believed the same spirit existed in the yellow metal foundry industry; and if the Control would give a definite lead, and any help and instruction they were able to supply, they need not fear resistance from the industry.

Commenting on the conflict of views concerning the use of charcoal as a cover to the silicon bronze melt, he said the two silicon bronzes dealt with in Part I of the Report differed in certain respects as regards composition, and he would like to hear whether Dr. Alexander thought that those differences would account for the need for charcoal in the one case and its prohibition in the other.

The Charcoal Enigma Solved

DR. W. O. ALEXANDER (I.C.I. Metals, Limited), dealing with the silicon bronzes, said the P.M.G. metal was developed essentially as a substitute for gunmetal in the days when tin was very expensive. Everdur, on the other hand, was developed primarily as a corrosion resistant alloy and secondly as an alternative for tin bronzes. It would be noted that all P.M.G. contained zinc, whereas for Everdur a zinc content of from 0 to 1.0 per cent. was specified. The reason why P.M.G. could withstand the use of charcoal as a cover to the melt was that there was a partial vapour pressure from the zinc, and the danger of a gas pick-up was not so great as in Everdur, which might be zinc-free. The makers of P.M.G. always preferred to have a charcoal cover to prevent oxidation, whereas in the case of Everdur some oxidation was tolerated; it was only very slight, because silica sand was quite protective, but it was desired to avoid any chance of absorbing gas from material such as charcoal.

Another point was that, inasmuch as there was no zinc in the original Everdur, there was a tendency towards some slight reaction between the sand of the mould and the metal during the pouring, but the presence of the zinc in P.M.G. inhibited that effect. Whereas zinc could not be tolerated in ordinary Everdur as used for chemical plant, yet in order to help the industry, and assuming there would be a call for silicon bronzes, the makers were prepared to add up to 2 per cent. of zinc. This addition should further assist in the founding and production of sound silicon bronze castings.

Recalling Mr. Bailey's reference to lead, Dr. Alexander said that item also emphasised a difference between P.M.G. and Everdur. P.M.G. contained iron, and always had a second constituent present in the form of iron silicide, and the presence of lead was not favoured. He suspected this may be because a complex iron-lead silicide may be formed; in any case, the presence of lead in P.M.G. would not produce so favourable an improvement in machinability, because although the actual machining might be improved yet the iron silicide particles were hard and tended to cause increased tool wear. By including lead in Everdur which was free from lead particles, the machinability could be improved; with small amounts of lead in Everdur there had been no untoward difficulty in producing sound castings. The reference to lead, in the Report, was included to emphasise that the possibility of mixing gunmetal or leady brass in silicon bronze melts, particularly Everdur, was not so bad as having Everdur mixed in gunmetal melts.

In order to help founders avoid this possibility, it was considered advisable to devise a spot test so that silicon bronze can be readily differentiated from the more normal melts such as gunmetal, brasses, leady brasses, etc.

(To be continued.)

CANADA'S STANDARD STOVES

To save iron and steel, curtailment of stove production in Canada has begun, and all stoves manufactured after present stocks of parts are exhausted will have to conform to rigid wartime specifications. Built for utility rather than for appearance, the new models will be cooking and heating machines and nothing more. The new order determines that the size, shape and design of every stove made after June 1 shall be fixed by the Controller, and it also allows for complete control of production. No stove of any kind will be manufactured without a permit, unless it is made for the Department of Munitions and Supply or the Department of National Defence.

BOOSTING BLAST FURNACE OUTPUT

INCREASED USE OF SINTER

A series of experiments on increasing pig-iron output of both large and small blast furnaces by increasing the percentage of sinter used in the burden has recently been completed by the Republic Steel Corporation. Test runs covering a period of four years have been made on blast furnaces in both the Cleveland and Youngstown plants of the company It has been found that by increasing the percentage of sinter in the furnace burden to as much as 40 or 50 per cent., the output of iron as shown by different furnaces can be increased anywhere from 10 per cent. to 19 per cent.

Present sintering capacity in U.S.A. is estimated to be about 13,000,000 tons. Not all of this, however, can be considered as available for the preparation of sinter of the high quality required to secure the most satisfactory blast-furnace operation. A programme, therefore, which involves increasing the percentages of sinter in the furnace burden from the present average of 10 or 15 per cent. to upwards of 45 per cent. would necessarily involve the construction of considerable new sintering capacity throughout the country.

The time factor, as compared with the time to build new blast furnaces, is markedly in favour of such a programme, states an article in "Steel." It should be possible to build a new sintering plant of, say, 1,200 tons capacity per day, in something less than six months. Only about 500 tons of steel are required in its construction and the plant with all necessary equipment, ready to run, can be constructed for approximately $600,000—or about 5 per cent. of the cost of a modern blast furnace.

Fig. 1 is a composite average of the performance of several Republic Steel blast furnaces operating on basic and Bessemer iron. The increase in daily iron production bears an almost direct relationship with an increase in the percentage of good quality sinter in the blast-furnace burden up to 45 per cent. No experience on the furnaces beyond this point is available; but results from another furnace on 100 per cent. sinter tend to indicate that beyond 45 per cent. there is little further advantage other than the increased iron units in the sinter. One of the prime reasons for this is that the burden becomes so open that the intimate gas-solid contact is not being maintained.

Another advantage of operating with increased per-

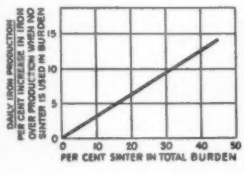

FIG. 1.—EFFECT OF SINTER ON THE DAILY IRON PRODUCTION.

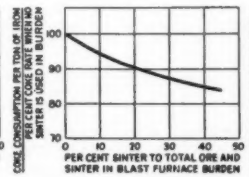

FIG. 2.—EFFECT OF SINTER ON THE BLAST FURNACE COKE RATE.

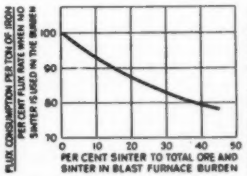

FIG. 3.—EFFECT OF SINTER ON THE BLAST FURNACE FLUX RATE.

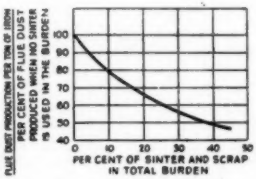

FIG. 4.—EFFECT OF SINTER ON THE FLUE DUST PRODUCTION.

TABLE I.—*Effect of Sinter on Blast Furnace Operation.*

Per cent.	Per cent. of consumption or production when no sinter is used in burden.			
	Consumption.		Production.	
	Coke rate (A).	Flux rate (A).	Flue dust (B).	Daily iron (C).
0	100.0	100.0	100.0	100.0
10	94.2	92.9	79.2	103.2
20	90.4	87.4	66.0	106.3
30	87.2	82.7	56.0	109.5
40	84.8	79.4	49.2	112.5
45	83.9	78.1	46.4	114.2

Based on the :

(A) Per cent. of sinter to the total ore and sinter in the blast furnace burden.
(B) Per cent. of sinter and scrap in the total burden.
(C) Per cent. of sinter in the total burden.

centages of sinter in the burden is the lower coke rates per ton of iron as shown graphically in Fig. 2. This again is a composite average of the several furnaces under test. Actually, however, the coke and flux consumption of the individual furnaces differed slightly at various percentages of sinter, but the percentage reduction in all cases was nearly the same. Whether this was the result of operating variations between the Cleveland and Youngstown furnaces or the effect of the quality of the sinter available could not be determined. The important thing was that a reduction in coke rate was evident in all cases. Since no additional coking facilities are required for an expanded sintering programme, what this means is that there is an actual decrease in coke consumption which is pure gain.

Fig. 3 shows the markedly lower flux per net ton of iron produced as the percentage of sinter in the blast furnace burden is increased. Also substantially less flue dust is produced as the percentage of sinter and scrap in the furnace burden is increased. This is shown in Fig. 4, where with 45 per cent. of these

(*Concluded on page* 96.)

SOUTH AFRICAN STRATEGIC MINERALS

In reply to the recent proposals that South African gold-mining operations should be curtailed in order to increase the output of the other minerals, the "South African Mining and Engineering Journal" considers that there seems no reason to believe that any further expansion of base minerals production could be achieved at the expense of the gold-mining industry, whereas it is certain that the entire South African war effort would suffer from any diminution of gold-mining activities. In view of the attention which the proposal has received the "Journal" reviews the production of strategic minerals which has taken place in the Union since the war began.

Chrome Ore

Among the urgently needed materials which South Africa is shipping in considerable quantities to the United States are manganese, chrome, asbestos, copper, corundum and industrial diamonds. Chrome ore production declined from 184,006 tons during 1939 to 117,279 tons in 1940, while output for the first six months of last year aggregated 72,406 tons. Limitation of inquiry to the higher grades of ore was among the reasons given for the downward trend in tonnage, substantial quantities of the lower grades having accumulated in the fields. Another reason for the falling off seems to have been a drop in local demand, which declined from 560 tons in the first half of 1940 to 235 tons for the corresponding period of last year.

On the other hand, exports have substantially increased during the past two years, the aggregate for the first six months of last year being 88,506 tons, as compared with 50,612 tons during the first half of 1940. Of the total shipments for the former period, no fewer than 85,939 tons went to the United States. Figures forwarded from time to time by the Union's Consul in New York reveal the dependence of the United States on South African chrome ore. Prospects for this material have been further improved by the discovery of high-grade ores and the introduction of mechanical grading.

Manganese Ore

Following the development of the extensive manganese deposits of the Postmasburg region, the Union became an important exporter of manganese ore. The record output of 557,210 tons achieved in 1937 placed South Africa third among the world's producers with an output exceeded only by Russia and India. In 1939 production declined to 388,154 tons, which in 1940 dwindled to 313,220 tons. During the first half of last year, however, the total output amounted to 245,919 short tons, against 212,713 tons in the corresponding period of 1940, though exports at 151,423 tons were slightly lower.

That production of a strategic mineral of such importance as manganese should be adversely affected by the war may seem surprising, until it is recalled that until hostilities began Germany was the principal importer of South African manganese ores, while important markets in France, Sweden, Holland and Spain have also vanished. Latterly, however, the loss of these markets has been completely offset by increased despatches to the United States, which during the first quarter of last year purchased 104,608 tons. During 1940 the Union was the principal supplier of manganese ore to the United States on the basis of gross weight, and was second only to India on the basis of metallic content; the total quantity of ore supplied by South Africa during the year being 235,400 tons, with a metallic content of 105,149 tons.

Mineral Output

Following a brief survey of corundum, asbestos, and copper production, it is recorded that, viewed as a whole, South Africa's mineral output rose in value from £110,537,082 in 1939 to £129,544,849 in 1940. Values do not afford a true comparison, however, and it is perhaps more significant that the output of 11,481,820 tons of base minerals achieved during the first six months of 1941 was 18 per cent. higher than that for the corresponding period of 1940. Indications point to the fact that shipping and marketing difficulties were the main factors that tended to retard the expansion of base minerals in the Union since the war began. But when these difficulties are eliminated, production will automatically advance to meet demand.

BOOK REVIEWS

National Companies, by Philip M. Robinson. Published by the Author, from Portland Works, Chesterfield. (Price 4½d., post free.)

It is our practice to ignore the receipt of political pamphlets, but this one is much more interesting than the usual run of such publications. It outlines a method of conducting large scale businesses after the war is over.

Definitions and Formulæ for Students—Metallurgy. By E. R. Taylor, D.I.C. (Second Edition). Published by Sir Isaac Pitman & Sons, Limited, 39-41, Parker Street, Kingsway, London, W.C.2. Price 6d.

The reviewer can only reiterate the praise he accorded this little book when it first appeared. It is excellent value for money, reliable and well balanced.

Canadian Steel Expansion

Since the beginning of 1940, Canadian steel production has increased almost 1,000,000 tons. Total steel furnace capacity, including basic open hearth, converter and electric, is now 3,268,000 net tons per year against 2,300,000 tons at the beginning of the war. Further expansion of primary steel production is underway. The Steel Company of Canada, Limited, is starting work immediately on the installation of a new Bessemer furnace and electric furnace, with equipment to cost approximately $2,750,000.

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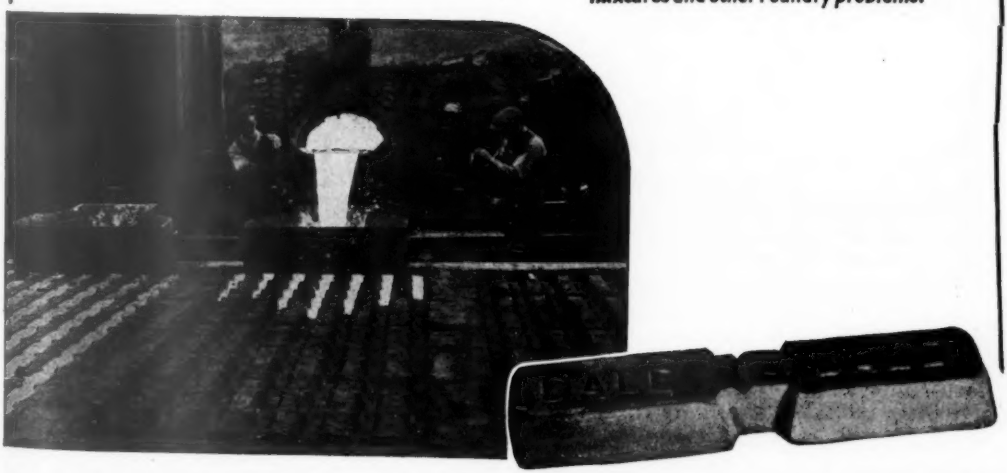
SHOULD BE USED to tone up high phosphorus irons and scrap, to replace Hematite, and to produce castings for all high duty purposes.

Users are invited to avail themselves of the Stanton Technical Service which offers free expert advice on special mixtures and other Foundry problems.



THE STANTON IRONWORKS COMPANY LIMITED, NEAR NOTTINGHAM

NEW PATENTS

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each.

546,779 BARKLIE, R. H. D., and LEWIS, A. Process for the joining of metals.

546,820 ALUMINUM COMPANY OF AMERICA. Heat-treatment of spontaneously-aged aluminium base alloys.

546,848 GROVES, W. W. (Moore, W. E.). Electrode supporting structure for electric arc furnaces.

546,871 PAYNE, P. M. Method of and apparatus for casting metal.

546,898 LEWIS, A. M. Method of producing an alloy.

546,899 FAIRWEATHER, H. G. C. (National Smelting Company). Aluminium base alloys.

546,906 CASTINGS PATENT CORPORATION. Castings mould for forming metal castings.

546,925 ALLMANNA SVENSKA ELEKTRISKA AKTIEBOLAGET. Means for regulating the temperature of a furnace or the like.

546,952 TRIGGS, W. W. (Carnegie-Illinois Steel Corporation). Feeding apparatus for metallic strips.

546,991 CASTINGS PATENT CORPORATION. Method of producing metallic castings.

547,025 PRESSED STEEL COMPANY, LIMITED, SIMMIE, W. S., and MURRAY, G. Heat-treatment of metal articles.

547,085 UDY, M. J. Production of alloys.

547,107 ELECTRO METALLURGICAL COMPANY. Production of malleable iron.

547,126 MAYNE, J. S., and DAVY & UNITED ENGINEERING COMPANY, LIMITED. Metal-shearing machines.

547,188 MOLLER, G. A. Process for metallisation of metal articles, especially aluminisation of iron articles.

547,217 NATIONAL SMELTING COMPANY. Heat-treatment of aluminium base alloy castings.

547,332 ANGLO-IRANIAN OIL COMPANY, LIMITED, and GREEN, A. D. Method for de-lacquering aluminium-rich alloy pistons.

547,363 WILSON, L. Methods of and apparatus for reducing oxides such as metallic ores.

547,408 PYRENE COMPANY, LIMITED (Parker Rust-Proof Company). Coating of iron or steel.

547,422 LAWSON, R. W., and SMITH, G. A. Steel helmets.

547,456 UDY, M. J. Production of solid agglomerates for use in metallurgical operations.

547,462 TOMLINSON, G. A. Instruments for measuring the roughness of surfaces.

547,483 INKLEY, B. H-section rails for supporting wall and ceiling lining boards, sheets, or slabs.

547,549 JOHANSEN, E. K. Presses for drawing sheet metal and like operations.

547,561 JENNINGS, H. W. K. (Scientific and Industrial Research, Honorary Advisory Council for). Rubber-coated metal and method of making the same.

NEWS IN BRIEF

THE WHITEHAVEN HEMATITE IRON & STEEL COMPANY, LIMITED, is being wound up voluntarily. Mr. G. H. Muriel, Kilner Park, Ulverston, is the liquidator.

AT AN EXTRAORDINARY GENERAL MEETING of the Monk Bridge Iron & Steel Company, Limited, held on September 15, a special resolution was passed "that the company be wound up voluntarily."

PROFIT of Rhodesia Broken Hill Development, Limited, for 1941 was £218,464, against £246,831 in 1940. Production of zinc and fused vanadic oxide proceeded satisfactorily, the report states.

THE MINISTRY OF SUPPLY is to start an intensive drive for non-ferrous scrap, and the public will be asked to give up brass nameplates, ornaments and similar articles. Public authorities are to help with the drive and to set up depots.

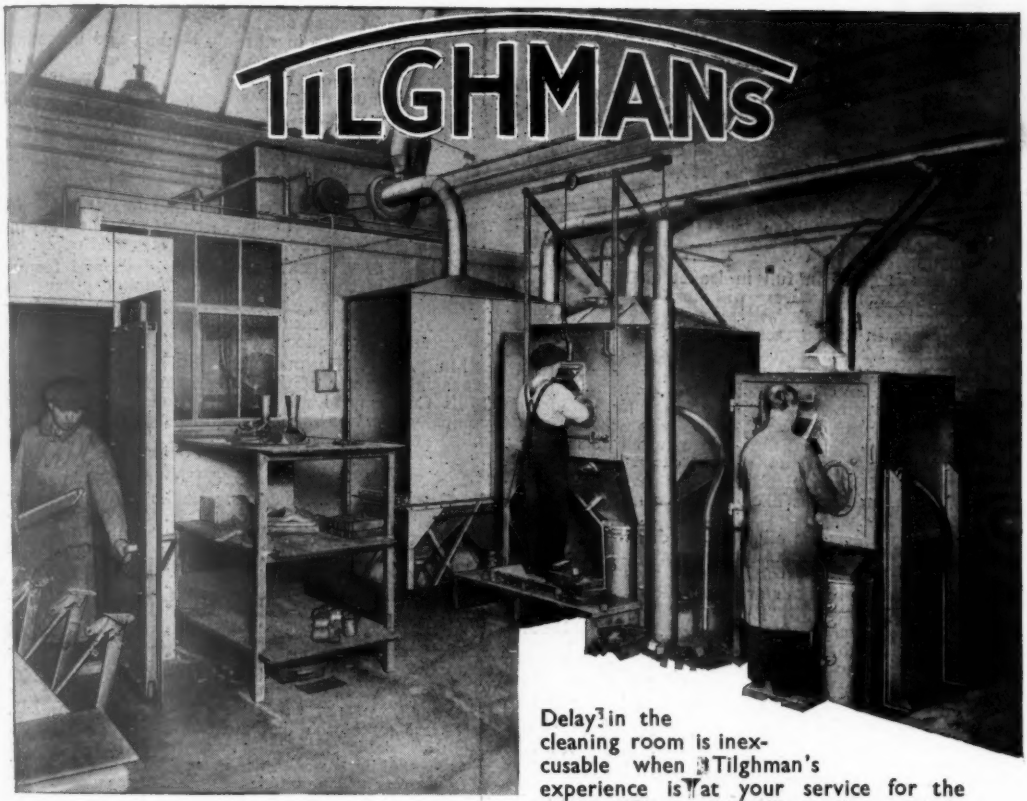
IRON RAILINGS collected up to the end of August totalled 300,000 tons, of which London yielded some 120,000 tons. The weekly rate of collection in London is now below 1,000 tons, but in other cities railings are being lifted at a weekly rate of between 5,000 and 6,000 tons.

THE TREASURY has advanced £100,000 to the South Wales Aluminium Company, Limited, on a debenture charged on land and premises and the company's undertaking and other property, present and future, including uncalled capital. The advance ranks *pari passu* with debentures for £200,000 issued in August, 1940.

THE ENGINEERING employers have received an application from the unions in the industry for an increase in wages. The claim is for an all-round increase of 11s. a week; an increase by 33⅓ per cent. of the base rates to all plain-time workers; and restoration of the overtime and other conditions which were in force before June, 1931.

ON THE INITIATIVE of officials and workmen of Newton, Chambers & Company, Limited, and Thorncliffe Coal Distillation, Limited, a new technical society for chemical engineering has been added to the Sheffield Trades Technical Societies which operate in connection with the Applied Science Department of Sheffield University. The president of the new society is Mr. P. J. C. Bovill.

AMONG RECENT ORDERS received by the Grinding, Screening and Filtering Division of International Combustion, Limited, have been the following: Hardinge ball mill for grinding cast-iron borings; Hardinge ball mill for grinding aluminium skimmings; Raymond screen pulveriser for grinding special materials; F2 Syntron feeder for cast-iron borings; Syntron vibrator for preventing packing of moulded sand in the facing and heap sand hoppers; four Syntron vibrators for vibrating shutes; one 3-ft. by 5-ft. Hummer screen for separating cast-iron borings; one 3-ft. by 6-ft. Tyrock screen for screening hot sand and gravel; ten Ro-tap testing sieve shakers for testing purposes.



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Delay in the cleaning room is inexcusable when Tilghman's experience is at your service for the asking. They will tell you how to get the best from your present plant, and if it is insufficient for your present needs, can supply the most modern machines to increase your output; cabinets as illustrated for small parts, rotary tables for heavier work, rooms for all sizes and shapes, and in addition, all the ranges of Airless Wheelabrators, the wonder cleaner for large production. Write for catalogues.

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WORKERS' CLOTHING COUPONS

SUPPLEMENTARY "INDUSTRIAL TEN"

In the last rationing period extra clothing coupons were given to workers in a number of particularly heavy occupations. In the light of the experience gained, the Board of Trade has been reviewing, in consultation with the Trades Union Congress and the British Employers' Confederation, the whole question of clothes for manual workers. With the help of these two organisations, a list of classes of workers who are now to have ten extra coupons has been drawn up.

The list is given in full in leaflet G.O.S.10, which it is hoped that employers will post on their works' notice-boards. The list will also be put up in trade union offices, in Employment Exchanges and elsewhere. The worker who is eligible and wishes to have the supplement must get a claim form—E.D.277—from his trade union or his employer. He fills it in and returns it to his employer. The employer then makes a collective application—on form E.D.279—on behalf of the claimants and distributes the coupons when he receives them. The self-employed worker should go to his nearest Employment Exchange and ask for form E.D.278. When he has filled it up, he must return it to the same Exchange.

Part-time workers are eligible provided they average at least 22 hrs. a week. Administrative and supervisory workers must not claim unless they are mainly engaged in manual labour or unless they work in conditions which mean heavy wear and tear on their clothes. Employers must hold all forms E.D.277 sent in to them by their workers in order that they may be referred to in case of doubt. Forms E.D.277 must not be sent to local offices. All application forms E.D.278 and E.D.279 must be completed and in the hands of the local offices of the Ministry of Labour and National Service before October 31, 1942.

The trades and occupations listed in leaflet G.O.S.10 include the following:—

Production and treatment of building materials and manufacture of refractories.

Manufacture and treatment of pottery, earthenware and glass.

Production and manipulation of the following or of goods incorporating them:—Heavy and fine chemicals, gases, luminous compounds, plastics, abrasives, gelatines, oils, fats, greases.

Production and treatment of metals.

Manufacture of metal products and of goods wholly or mainly of metal.

General, marine, constructional and electrical engineering.

Manufacture and maintenance of electrical goods and equipment.

Cooking, preparation and service of foods, including incidental kitchen work, where such foods are offered for sale or consumed in other than private residences, but not the serving of drinks.

Works and plant and laboratory chemists and their assistants; laboratory workers.

Boiler firemen, ashmen, stokers, cleaners and scalers.

Office and factory cleaners.

Workers engaged in shifting, loading and unloading heavy, dirty or corrosive goods.

Workers not otherwise covered, but engaged on essential manual operations and services in connection with any of the trades listed.

PERSONAL

MR. D. M. MOFFAT, of Tube Investments, Limited, has been appointed to be Deputy-Controller of Inspection Administration in the Ministry of Supply.

MR. H. J. ALLCOCK, production officer and former process manager of Callender's Cable & Construction Company, Limited, has been appointed Director-General of Communications Equipment in the Ministry of Aircraft Production.

MR. A. B. HANDLEY has been appointed joint managing director of the Rotherham Forge & Rolling Mills Company, Limited. Mr. Handley entered the company's service in 1915 as manager of the rolling mills department and was appointed a director in 1929.

MR. SIDNEY R. PARK entered the firm of Wm. Park & Company, Forgemasters, Limited, Wigan, fifty years ago, and to commemorate the occasion presentations were made to him recently by the directors, staff and employees, and also by the staff and employees of English Tools, Limited.

MR. OWEN D. YOUNG, retired chairman, and Mr. Gerard Swope, former president of the General Electric Company, of New York, will return to their old positions for the duration of the war, as their successors, Mr. Philip Reed and Mr. Charles Wilson, are now working for the U.S. War Production Board.

A PERSONAL LETTER from Mr. W. B. Lake, J.P., past-president of the Institute of British Foundrymen, tells us that his son, Capt. P. B. Lake (not Lieut., as we reported last week), is, as we stated, a prisoner of war in Italian hands. We are repeating this information, as a casualty list issued by the Ministry of Information stated incorrectly that Capt. Lake had been killed.

Wills

SMITH, J. L., of Kirby in Cleveland, retired iron-founder £77,527

SMITH, R. P., of Sheffield, steelworks director, formerly of Cambuslang £20,518

HEARN, W. F., director of the Wexford Engineering Company, Limited £27,044

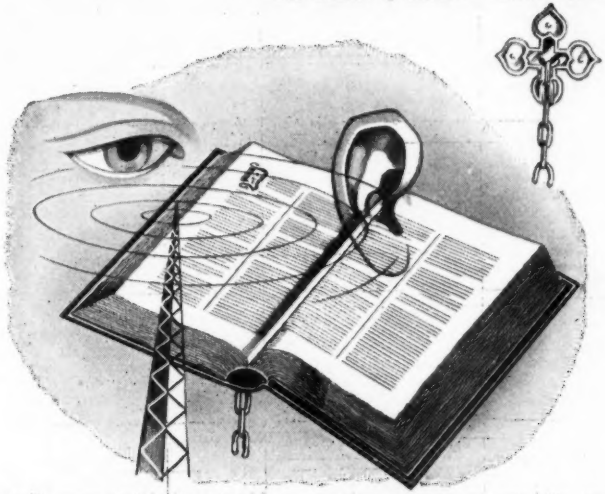
SCIENTIFIC AND INDUSTRIAL RESEARCH COUNCIL

The Lord President of the Council has appointed Sir Lawrence Bragg, Prof. J. E. Lennard-Jones, Dr. A. McCance and Sir Raymond Streat to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research from October 1, 1942. Dr. G. M. B. Dobson and Mr. S. K. Thornley will retire from the Council on completion of their terms of office on September 30, 1942.

SEVEN PILLARS OF PROGRESS

7. The pursuit of scientific inquiry demands complete intellectual freedom and unrestricted international exchange of knowledge and it can only flourish through the unfettered development of civilised life.

"The Charter of Science"—British Association, 1941



When books were chained, learning was confined to the few, and the world, in general, advanced little beyond barbarism. Three centuries of unfettered knowledge have now enhanced the lot of mankind. The pace grows faster as communications between order-loving nations grow and increase. Progress in civilisation is a function of the ability to interchange information frankly, whereby man may learn from his fellows. All peoples must be free to enjoy intellectual liberty without fear or restraint.

In the realm of steel this organisation will continue to pursue scientific inquiry through the medium of their scientists and technologists. We are willing at all times to disseminate the fruits of these labours for the benefit of our fellows. Much has been contributed towards the progress of metallurgical science in the past and it is our earnest hope that in the years ahead, when the shadow of barbarism has passed from all the shackled territories, that we may take an even greater part in helping to create a free and unrestricted international democracy of science based on the highest ethical standards.

THE UNITED STEEL COMPANIES LTD

THE UNITED STEEL COMPANIES LIMITED

Steel, Peech & Tozer, Sheffield | Appleby-Frodingham Steel Co. Ltd., Scunthorpe | The Rothervale Collieries, Treeton
Samuel Fox & Co. Ltd., Sheffield | Workington Iron & Steel Co., Workington | United Coke & Chemicals Co. Ltd.
United Strip & Bar Mills, Sheffield | The Sheffield Coal Co. Ltd. | Thos. Butlin & Co., Wellingborough

U·S.P.7

COMPANY NEWS

(Figures for previous year in brackets.)

Hopkinsons—Interim dividend of 5% (same).

Imperial Chemical Industries—Interim dividend of 3% (same).

Vickers—Interim dividend of 4% on the ordinary stock (same).

United Steel Companies—Final dividend of 5½%, making 8% (same).

Kay & Company (Engineers)—Dividend on the ordinary shares of 12½% (same).

Newall Engineering Company—Interim dividends of 5% on the "A" and "B" ordinary shares (same).

Fodens—Net profit for the year to May 31 last, after tax, £30,182 (£31,275); ordinary dividend of 8% (same).

Warne Wright & Rowland—Net profit for 1941, £12,615 (£14,814); dividend on the ordinary shares of 15% (7½%).

Darlington & Simpson Rolling Mills—Dividends on the 5½% first and 6% second preference shares for the half year to September 30.

Follsain Metals—Net profit for 1941 of £3,764 (£2,966), subject to E.P.T. Balance of loss carried forward is reduced from £22,847 to £19,082.

Bennis Combustion—Profit for the year to April 30, 1942, after depreciation and provision for contingencies, £29,034 (£28,883); balance, after taxation and other items, £17,709 (£14,833); ordinary dividend of 10% (same); to reserve, £4,000 (£1,000); forward, £3,758 (£3,549).

Staveley Coal & Iron Company—Profit for the year ended June 30, including dividends from other companies, £949,744 (£997,304); written off stock values, £90,000; war damage insurance, £9,488; taxation, £347,000; depreciation, £220,622; net profit, £271,635 (£294,429); to general reserve, £50,000; dividend of 6½%, free of tax; forward, £135,466 (£133,879).

Sheepbridge Coal & Iron—Profit for the year to June 30, after tax, £207,532; depreciation, £38,051; debenture interest, £8,911; net profit, £155,929 (£177,236); dividend on the ordinary and participating preference stocks of 8%, tax free (9%, tax free), £117,790 (£132,514); to reserve for renewals, £20,000 (same); to deferred repairs, £10,000 (nil); to war damage insurance, £5,000 (£20,000); forward, £118,321 (£115,181).

Neepsend Steel & Tool Corporation—Net revenue for the year to March 31 last, £135,594 (£148,703); the additional dividend of 4% (same) on 6% preference shares, and a final dividend of 15% (same) on the ordinary stock, together with a bonus of 20% (same), making 50% (same) for the year; reserve for contingencies, £10,000 (same); reserve fund, £10,000 (same); reserved for E.P.T., £35,000 (£40,000); welfare fund, £2,000 (same); forward, £13,545 (£12,970).

SIR EUGENE RAMSDEN has been appointed deputy-chairman of Thomas Bolton & Sons, Limited, copper refiners. Messrs. D. W. Aldridge, W. G. Hendrey and W. H. McFadzean have been appointed directors of the company.

NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Georges Engineering Company, Richmond Road, Atherstone—£5,000.

Goodman's Engineering, 35, London Lane, London, E.8—£5,000. J. and A. Goodman, I. A. Perkins, and H. H. S. Courtenay.

Banks (London), 111, High Street, Clapham, London, S.W.—Engineers, etc. £10,000. Sir H. Macneal, E. J. Evershed, and N. J. Neville.

Richford Engineering Company (Chilwell), 47, High Road, Chilwell, Notts—£2,000. J. B. Richmond, F. W. Radford, and E. G. Burnham.

R. E. Barker & Company, Mill Foundry, Knottingley, Yorks—Colliery engineers. £1,500. R. E. and A. Barker, and M. K. Williams.

Alexandra Furnaces—Founders, furnace constructors and repairers, etc. £1,000. H. H., W., and W. E. Williams, 6, Warwick House, Castle Court, Westgate Street, Cardiff.

S. W. Goosey, 8A, Courtenay Street, London, S.E.11—Engineers, contractors, manufacturers of fire appliances, etc. £6,000. T. S., M. A., and M. E. Goosey, and D. R. Jose.

Trojik Manufacturing Company, Works Road, Letchworth, Herts—Electrical and general engineers, founders, etc. £4,000. H. J. and W. E. Stacey, E. C. Lockie, and J. C. Knowles.

OBITUARY

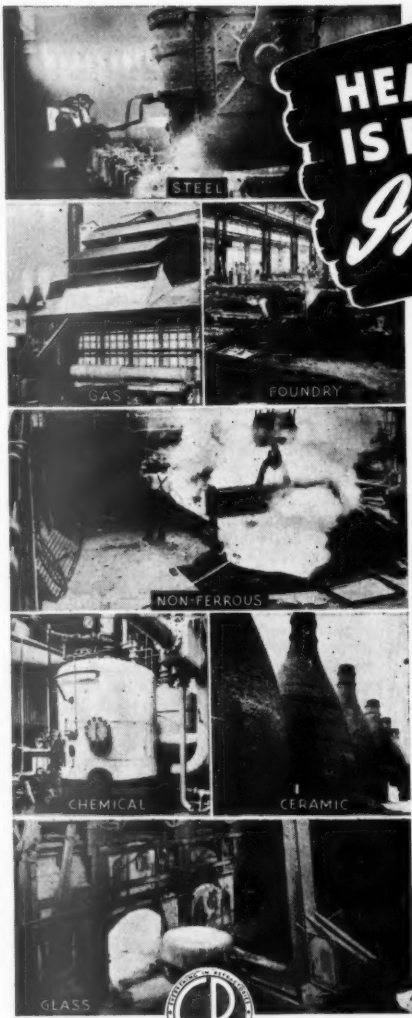
MR. T. C. PHILLIPS, senior partner of Phillips & Rabone, brassfounders, has died suddenly at Sutton Coldfield.

MR. ALFRED E. THOMAS, a prominent figure in the iron and steel industry in Middlesbrough and the Midlands, died at his home at Barnt Green, Worcestershire, on September 16. He was in his 81st year.

SERGT.-PILOT DENIS JAMES CURLING, R.A.F.V.R., only son of Mr. B. C. Curling, secretary of the Institute of Marine Engineers, is reported to have been killed in action over occupied France in June last. He was 21 years of age.

MR. ALBERT KING, whose death has occurred at Darlington at the age of 62, was for many years commercial manager of the Darlington Railway Plant & Foundry Company, Limited. He was associated with the firm for 41 years. He started his career with Thomas Summerson & Sons, Limited, railway plant makers, Darlington.

SEVERE REGULATIONS have been introduced to control French consumption of iron and steel. The manufacture of a large range of household articles has been forbidden, and tinplate may in future be used only for the production of containers for foodstuffs and certain medical goods.



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Raw Material Markets

IRON AND STEEL

Considering that it is now more than three years since the nation was plunged into war, the position of the iron and steel industry as far as supplies of raw materials are concerned is much healthier than would seem possible when the events of the war are reflected upon. The collapse of France, the loss of vast tracts of Empire territory, the strain of supplying the Soviet Union with large quantities of materials, and the heavy toll of shipping by the U-boat campaign, are but a few of the many factors which have vitally affected our raw material resources, while the United States of America now has to restrict exports because she has to cater for a war machine of her own. While our allies on the other side of the Atlantic are still rendering enormous assistance to the warring nations of Europe and elsewhere, this aid is now mainly in the form of finished articles. Consequently, the British iron and steel industry is now largely supported by home-produced materials, and the results to date have been extremely gratifying. Iron ore found in the United Kingdom is suitable chiefly for the production of iron of a high-phosphorus character, so that the output of hematite and low-phosphorus irons, etc., is considerably curtailed. This has inevitably caused a certain amount of inconvenience, as the heavy engineering section of the industry was formerly dependent upon supplies of these grades, but with the utilisation of a large proportion of high-phosphorus and refined irons and steel scrap the heavy engineers have recorded very satisfactory outputs.

Business in the heavy-castings trade is brisk, as the products of the works in this category are in great demand by the various Government departments. The light-castings trade, on the other hand, is under the shadow of the concentration-of-industry plans which the Government is applying to all industries where the capacity is greater than is required to meet essential war and civil needs. This is true of the light foundries, many of which have been on short time for a long period. Demand for castings from the building industry is much below the normal level, despite the appreciable volume of building being carried out by the Government, while the export market is virtually dormant.

Bookings at the steelworks for deliveries in the first quarter of the year, which commenced to-day (Thursday), are very brisk, and the industry is assured of active operations for the remainder of the year. High-grade metal is required for the armaments and munitions works, and production is being enlarged at every opportunity.

NON-FERROUS METALS

Supplies of copper and tin are sufficient to satisfy the demand for war purposes and, generally speaking, any surplus is being put into stock rather than distributed among less urgent consumers, as, while the current position gives no cause for undue concern, all things considered, the Control authorities are anxious to guard against the future.

Further restrictions on the use of tin are contained in an Order issued by the Ministry of Supply, which came into operation on Friday last. Restrictions are imposed upon the manufacture from tinplate of whole or certain parts of containers used for the distribution on the home market of a number of commodities, including some foodstuffs. They have, however, been designed to ensure that adequate protection of the product packed can be obtained by the use of containers made from steel coated not with tin but with a protective lacquer or varnish, which is still permitted under the terms of the Order, the Control of Tins, Cans, Kegs, Drums and Packaging Pails (No. 8) Order, 1942.

A meeting of the International Tin Committee was held in London on Monday, when it was decided that the tin quota shall be continued until further notice at 105 per cent. of the standard tonnages. The Committee decided that if any territory was able to exceed this amount the quota would be increased retrospectively and generally in order to cover the actual production of that territory. In pursuance of its general policy, the Committee also decided that there should be no actual carry-forward of any deficiencies in export from one year to another until further notice. It was further disclosed that an agreement for the international control of the production and export of tin was signed at the Foreign Office on September 9 by representatives of the Governments of the United Kingdom, Bolivia, Free Holland and Free Belgium. The text of the agreement will be issued to-morrow (Friday). The amendment adds that the policy of the Committee is to encourage during the war the maximum possible production of tin in all territories not under enemy control. Sir John Campbell, the chief British representative, was re-elected chairman of the Committee, while Mr. P. H. Westermann, until early this year Trade Commissioner for the Dutch East Indies in London, was elected vice-chairman for the period covered by the new agreement. It will be recalled that at the beginning of December last the International Tin Committee announced that five countries—Bolivia, the Belgian Congo, the Netherlands East Indies, Nigeria and Malaya—had accepted the new standard tonnages and agreed to continue tin regulation for a further five years from January 1, 1942. The quota was fixed at 105 per cent., which corresponds closely to 130 per cent. of the standard tonnages under the old agreement.

Demand for lead from the war factories is certainly great, but it is doubtful if consumption of the metal is on the scale that it was in pre-war days, when the building industry was responsible for very large tonnages. In 1938 some 385,000 tons of lead was consumed in this country. At the moment, the battery and cable industries are absorbing large tonnages, but building requirements are nothing like so great as they were, despite the considerable volume of constructional work that is being carried out by Government departments.

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FOUNDRY TRADE JOURNAL
Established 1902
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'Phone : HIGH WYCOMBE 1792 (3 lines).

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COUNCIL OF IRONFOUNDRY ASSOCIATIONS

Chairman : FitzHerbert Wright, The Butterley Company, Ripley near Derby. Secretary : V. Delport, 2, Caxton Street, Westminster, S.W.1.

Participating Associations : British Bath Manufacturers' Association ; British Ironfounders' Association ; British Malleable Tube Fittings Association; Cast Iron Axlebox Association ; Cast Iron Chair Association; Cast Iron Heating, Boiler and Radiator Manufacturers' Association; Cast Iron Segment Association ; Greensand Pipe Founders Association of Scotland; Ironfounders' National Confederation ; National Association of Malleable Ironfounders ; National Ingot Mould Association ; National Ironfounding Employers' Association; Agricultural Engineers' Association (affiliated) ; British Cast Iron Research Association (affiliated); British Grit Association (affiliated); Institute of British Foundrymen (affiliated).

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